Short-term variations of HCl and HF trends observed with FTIR at Tsukuba and Rikubetsu

Isao Murata[1], Yoshihiro Tomikawa[2,3], Isamu Morino[4], Hideaki Nakajima[4], Hideharu Akiyoshi[4], and Tomoo Nagahama[5]
[1]*Graduate School of Environmental Studies, Tohoku University, Sendai, Miyagi, Japan*
[2]*National Institute of Polar Research, Tachikawa, Tokyo, Japan*
[3]*SOKENDAI (The Graduate University for Advanced Studies), Tachikawa, Tokyo, Japan*
[4]*National Institute for Environmental Studies, Tsukuba, Ibaraki, Japan*
[5]*Institute for Space-Earth Environmental Research, Nagoya University, Nagoya, Aichi, Japan*

HCl is a main chlorine reservoir species in the stratosphere. The amount of HCl is a good indicator of the potential for ozone depletion. Observed total column of HCl was decreasing in the 2000s after CFC regulations were introduced but showed increase from 2007 to 2011. Mahieu et al. [2014] investigated that this increase is due to interannual dynamical variability in the northern stratosphere from the observations with Fourier Transform Infrared spectrometer (FTIR) at 8 sites including Tsukuba and 3D-chemical transport model simulations.

In this study we extended the analysis of HCl observed with FTIR at Tsukuba to 2019 and the analyses of HCl at Rikubetsu and HF at both sites were also added. HF is a good tracer of atmospheric transport. Figures 1 and 2 show the temporal variations of 4-years-trends of HCl and HF at both sites, respectively. Note that the observation periods are different between both sites. HCl showed decrease between 2003 and 2007 and increase around 2009 at both sites which is consisitent with the result of Mahieu et al. [2014]. It showed increase again in 2016 and 2017 then decease in 2018. HF also showed decrease (or small increase) around 2005 and 2006 and increase around 2009 at both sites. It showed increase again in 2016 then decease in 2018. These trends at both sites approximately agree and can be basically explained by the stratospheric circulation change investigated from mass stream function calculated from ERA-Interim meteorological data.

The situation is somewhat different for the period around 2016. The difference of mass stream function between the average of 2011 - 2014 and the average of 2015 - 2018 shows negative values in the northern lower stratosphere which means the deceleration of circulation and this is also consistent with the increase of HCl and HF observed around 2016. However, MIROC3.2 Chemistry-Climate Model (CCM) results show that the decrease rates of HCl and HF at Tsukuba became lower but continue to decrease around 2016. This means that the circulation change around 2016 isn't enough to explain the trend reversal and there are some possibility that the emission change in CFC-11 affects the increase of HCl and HF around 2016.

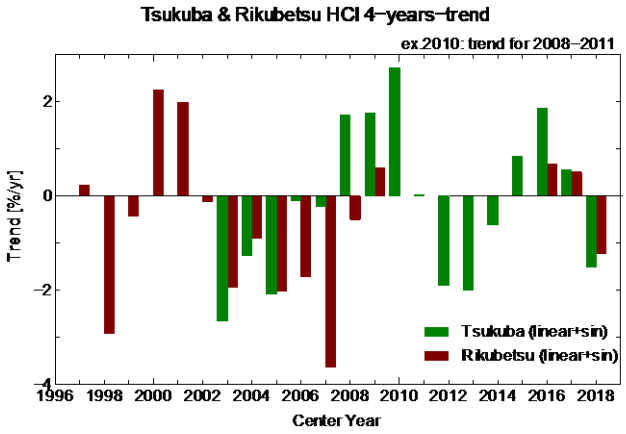

Figure 1. HCl trend variations at Tsukuba and Rikubetsu.

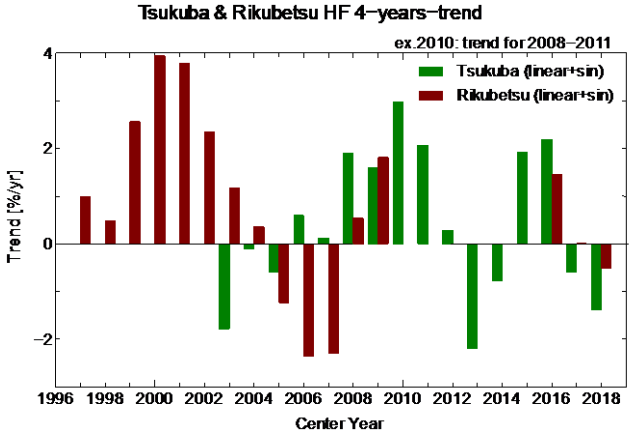

Figure 2. HF trend variations at Tsukuba and Rikubetsu.

References

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